

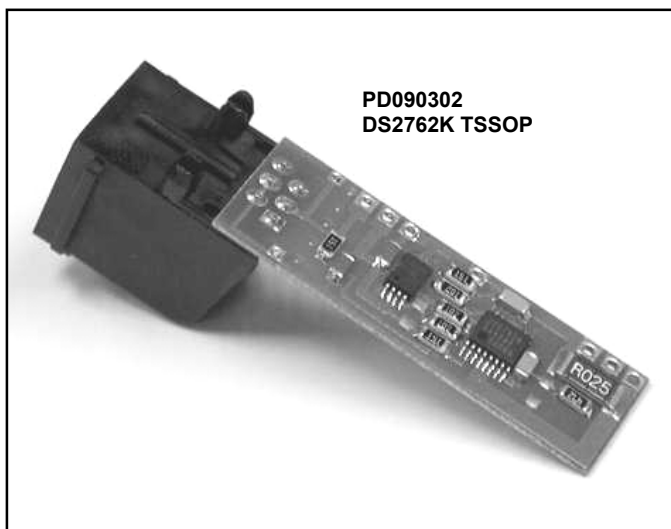
GENERAL DESCRIPTION

The DS2762K evaluation kit makes performance evaluation, software development, and prototyping with the DS2762 Lithium-Ion (Li+) battery monitor easy. The evaluation board interfaces to a PC through a DS9123 serial-port adapter and RJ-11 cable connection. The provided CD ROM contains all related data sheets along with the evaluation software, which can be run under any Windows® operating system.

The DS2762K evaluation software gives the user complete control of all functions of the DS2762. Separate control tabs allow the user access to all EEPROM and RAM memory locations, all control registers, and real-time updates of all monitored parameters. The software also incorporates a data-logging feature to monitor a cell over time and fuel-gauging algorithms to improve remaining capacity calculations based on specific cell characteristics.

The evaluation board circuit is designed to provide the DS2762 with accurate parameter measurements, allow the DS2762 to disable charging or discharging, and protect the DS2762 from ESD damage. Kit demonstration boards will vary as they are improved upon over time. For information on the demonstration board circuits, refer to the individual board data sheets located inside the documentation directory on the DS2762K CD ROM.

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FEATURES

- **Demonstrates the Capabilities of the DS2762 Li+ Battery Monitor, Including:**
 - Temperature Measurement
 - Voltage Measurement
 - Current Measurement
 - Current Accumulation
 - Temperature and Accumulated Current Alarms
 - Information Storage
 - Identification
 - Overvoltage/Undervoltage Protection
 - Overcurrent/Short-Circuit Protection
- **Interfaces to the Serial Port of a PC Running Windows OS**

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EVALUATION KIT CONTENTS

- 1–2 pc. TSSOP or CSP Evaluation Boards of different varieties
- 1 pc. DS9123 Serial-Port Adapter
- 1 pc. RJ-11 Cable
- 1 pc. DS2762K CD containing:
 - DS2762K Evaluation Software
 - DS2762 Related Documentation

EQUIPMENT NEEDED

- 1) A PC running Windows OS with a CD ROM drive and an available serial port.
- 2) Cables with mini-grabber-style clips or the ability to solder directly to connection pads.
- 3) A Li+ battery and a power supply and/or load circuit.

DS2762 INFORMATION

For more information about the DS2762, refer to the DS2762 data sheet available on our website at www.maxim-ic.com/DS2762.

SETUP AND INSTALLATION

Board Connections

Connections to the TSSOP demonstration board are best made either by soldering directly to the pads or by using cables with mini-grabber clips. Soldering directly to the pads best makes connections to the CSP board. Communication to the TSSOP board can be accomplished either through the RJ-11 jack by connecting the provided standard six conductor RJ-11 cord, or by wiring directly to the DQ and PAC- pads. In the latter case, the size of the board can be reduced by snapping off the RJ-11 jack along the break line (see Figure 1). To use the demonstration software, the DQ and PAC- lines must be connected to the DS9123 communication brick using either of the two methods described.

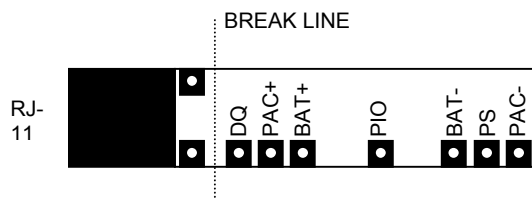


Figure 1. Communication Connections

Figures 2a and 2b show the recommended circuits to simulate charging and discharging. The Li+ cell is connected between the BAT+ and BAT- pads. The battery charger/power supply or circuit load is connected between the PAC+ and PAC- pads. The evaluation software can be run in either configuration as long as a cell is connected between the BAT+ and BAT- terminals, providing a minimum of 2.5V to power the DS2762. Some board versions also have connections for the PS and PIO pins. Refer to the data sheet for the operation of these pins. Leaving them unconnected does not interfere with the operation of the demonstration board.

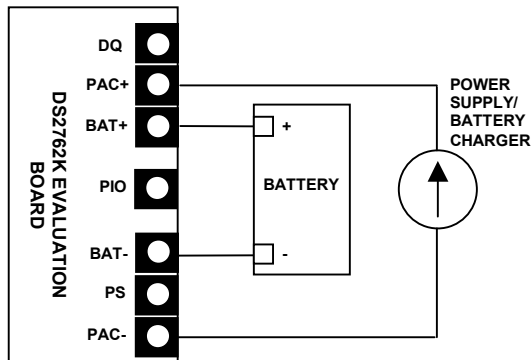


Figure 2a. Charging Circuit

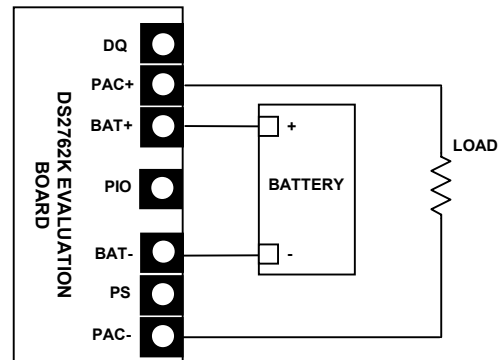


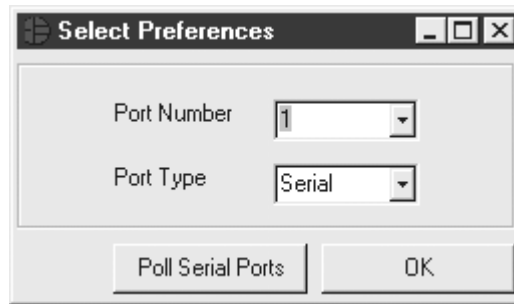
Figure 2b. Discharging Circuit

SOFTWARE INSTALLATION

To install the DS2762K software, exit all programs currently running and insert the DS2762K software CD into your computer's CD ROM drive. Double click the SETUP.EXE icon and the installation process begins. Follow the prompts to complete the installation. The DS2762K software can be uninstalled in the Add/Remove Programs tool in the Control Panel. After the installation is complete, open the DS2762K folder and run DS2762K.EXE or select DS2762K from the program menu. A splash screen containing information about the evaluation kit appears as the program is being loaded. The Documentation directory also located on the CD contains all relevant data sheets and application notes on the DS2762 and DS2762K.

SELECTING THE COMMUNICATION PORT

The first time the software runs, the Select Preferences window appears. In this window, select either serial port or USB communication and the port number; then hit OK. The DS2762K software saves this port selection and automatically uses the selection each time the program starts. To change the port later, click the Preferences option on the menu bar, select Port Settings, and then select the appropriate port. To attempt to automatically locate the DS9123, click the Poll Serial Ports button. **Warning:** Automatically polling for the DS9123 can disrupt other devices connected to your computer's COM ports.



MENUS

Several pull-down menu options have been provided to simplify use of the DS2762K software. Their functions are individually detailed below.

File Menu

The File Menu allows the user to store information from a file directly into the Device Setup, Battery Data, and Fuel-Gauging Data sections under the Pack Info Tab, or take the same Pack Information and store to a file. These functions do not directly write or read the DS2762. It is still necessary for the user to store or recall this information to or from the device by issuing a WRITE or READ command under the Pack Info Tab.



Registers Menu

The Registers Menu gives immediate access to all four status and function registers of the DS2762. Selecting any of the registers will open an individual control window giving the user a description of each register bit and the ability to read or write it. See the status register window example.



Status Register

The present state of all register bits is displayed immediately upon opening the register window. R/W locations contain a selection field to allow the user to determine their state. Pressing either the APPLY or OK button in the EEPROM Register or Special Feature Register windows will automatically update and read the corresponding register inside the DS2762. The Protection and Status registers have default values stored in user EEPROM addresses 0x30h and 0x31h, respectively. Their windows contain extra options to write or read these locations independently of their registers.

Bit	Register	Field	Value
Bit 5	PMOD	Sleep Mode is :	Disabled
Bit 4	RNAOP	Read Net Address Opcode Set to :	33h
Bit 3	SWEN	SWAP Command is :	Disabled
Bit 2	IE	Interrupt Enable is :	Enabled

Buttons: Recall & Read Address 31h, Write & Copy Address 31h, Read Address 01h, Done

Preferences Menu

The Preferences Menu allows the user to change COM port settings at any time. Edit Preferences opens the Select Preferences window. See Selecting the communication port above.



Help Menu

Selecting the About topic from the Help Menu opens a window containing information about the current revision of this program and Dallas Semiconductor.

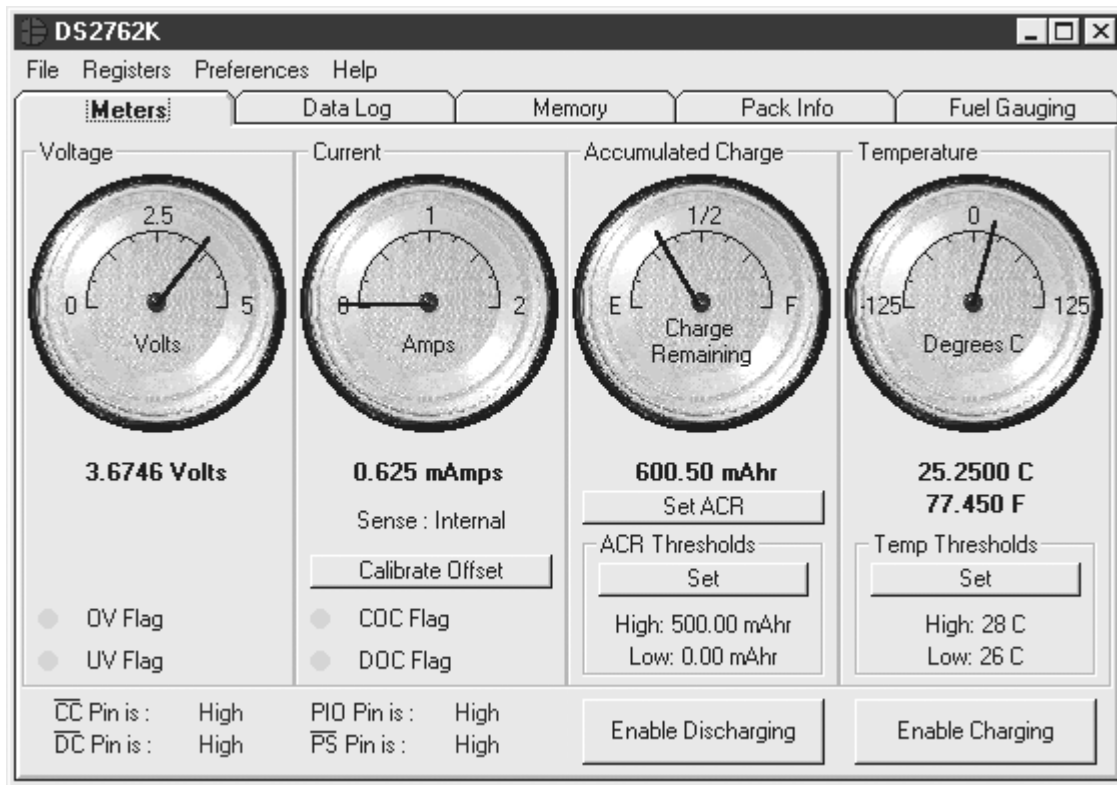


PROGRAM TABS

All functions of the program are divided under five tabs in the main program window. Left click on the appropriate tab to move to the desired function page. Located under the Meters tab is information on real-time updates measured by the DS2762: voltage, current, accumulated charge, temperature, alarms, and all error flags. The Data Log tab allows the user to store all real-time information including protection register state to a file. The Memory tab displays the contents of every register and memory location inside the DS2762 and allows the user to alter the data. The Pack Information tab gives the user the ability to assign a default device configuration and store that information to the DS2762 and/or a file. The Fuel Gauging tab uses the cell characterization information stored under Pack Info to maintain a high-accuracy-remaining capacity indicator.

Meters Tab

The Meters Screen displays the latest real-time measurements of cell voltage, temperature, current, and accumulated charge with both analog meter readouts and digital values. The sense resistor value used to calculate the current reading is shown in the current section. Left click on it or go to the sense resistor sub-tab under Pack Info to change this value. The Calibrate Offset button in the current section allows the user to zero the current measurements under the conditions of their circuit. Left clicking this button will begin the automatic calibration procedure. Calibration should be performed while the pack is disconnected and there is no current flow. The next 32 readings will be averaged and the offset eliminated by adjusting the Current Offset Register (location 0x33h) automatically. The process takes approximately 20 seconds.



The user can bring up the Update Current Accumulator window by left clicking the Set ACR button. This window allows the user to enter values for the Current Accumulator Register and Rated Battery Capacity in mAH. Rated Battery Capacity is used to determine full-scale range on the Charge Remaining Meter only. It has no effect on device operation.

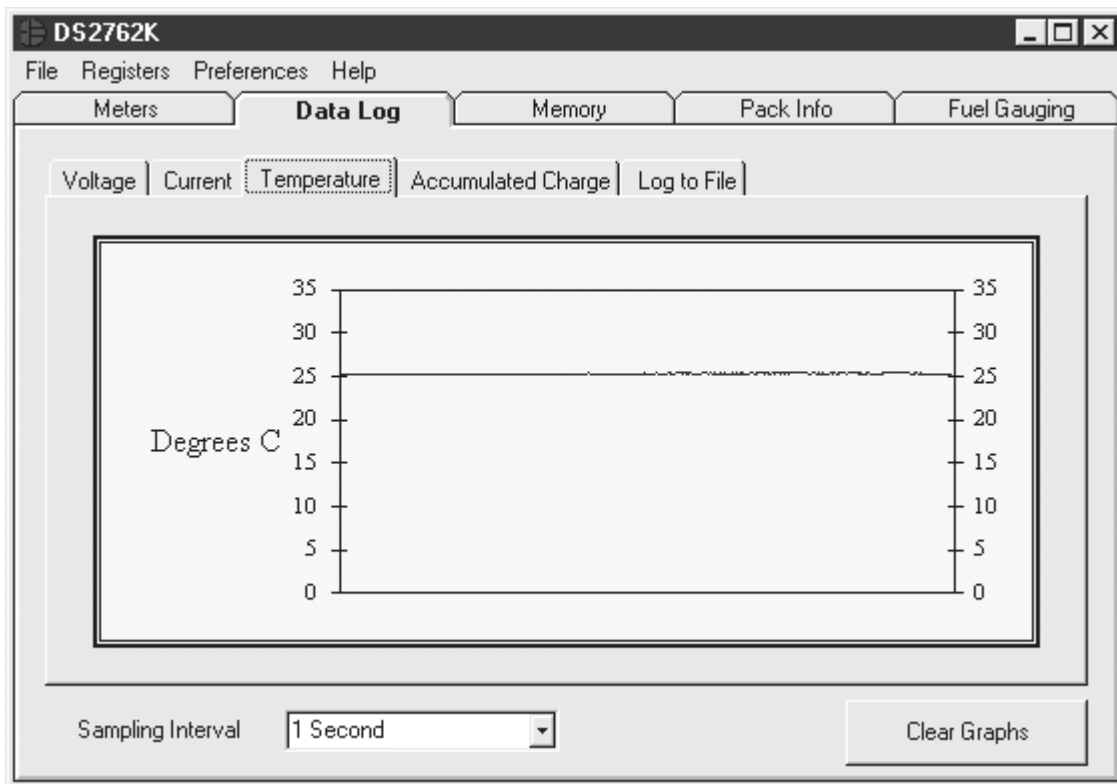
The present states of the Charge Control and Discharge Control pins are shown at the bottom left of the window. These outputs are active low and drive two control FETs allowing charging and discharging of the cell pack. The Charge Control pin can be controlled manually by left clicking the Disable/Enable Charging button and will be forced high automatically by either an overvoltage or charge-overcurrent condition. The Discharge Control pin can

also be controlled manually with the Disable/Enable Discharging button and will be forced high automatically by either an undervoltage or discharge-overcurrent condition. The present state of each of the four possible flag conditions (Overvoltage, Undervoltage, Charge Overcurrent, and Discharge Overcurrent) is represented by LEDs inside the voltage and current sections of the window. The corresponding LED will be green while the flag is in the cleared state. If conditions cause a flag to be tripped, the LED will turn red and a button will appear that allows the user to clear the flag provided clear conditions have been met. If conditions for clearing the flag have not been met by the circuit, clicking the clear button will have no effect.

The bottom right side of the screen shows the alarm settings. Press the corresponding Set button to enter high and low values for Temperature and Accumulated Current. When the temperature or accumulated current exceed any of the alarm values, the alarm indicator is displayed. The alarm indicator is a read of the PIO bit, which doubles as the alarm bit when enabled.

Datalog Tab

The Datalog tab allows the user to see the DS2762's parameter measurements graphed over time. There are separate sub-tabs for voltage, current, temperature, and accumulated charge. Each graph displays the last 500 data points collected by the DS2762K software. The sampling interval can be adjusted from as fast as possible to 15 minutes and can be adjusted from the Sampling Interval Menu at the bottom of the window. The Clear Graphs button will clear all data from all four graphs, but does not reset the log to file function.



The Log to File sub-tab contains control information for storing all log data to an ASCII file. The default filename is c:\DS2762K_datalog.txt, but can be modified in the filename text field. The Log Data button toggles data logging off and on. Data will be stored at the same interval selected for updating the graphs in the tab-delimited format of

"Time<tab>Voltage<tab>Current<tab>Temperature<tab>CA<tab>Protection Register"

for easy import into a spreadsheet. The most recent 50 samples are displayed in the window for observation.

Warning: The Log Data function overwrites previous file information. Data previously stored in the file will be lost.

Memory Tab

The Memory Tab gives the user access to all 12 register, 32 EEPROM, and 16 SRAM bytes inside the DS2762. They are separated into four sub-tabs for convenience. Clicking in that address' text box and typing a new value in hexadecimal format can modify any value. The Write button copies the entire block of data to the corresponding location inside the DS2762 (Scratchpad RAM on the EEPROM blocks). The Read button updates the entire block's text boxes with data from the DS2762 (Scratchpad RAM on the EEPROM blocks). Sub-tabs displaying any EEPROM data also have Copy and Recall buttons to allow the user to transfer the data between Scratchpad and EEPROM memory internal to the DS2762. The Permanently Lock Block 0/1 buttons permanently store the data currently located in that block's EEPROM if the LOCK bit in the EEPROM register is set. Otherwise, this button does nothing. **Warning:** This data can never be changed once locked. Verify your data first by issuing a Recall and a Read.

	Address		Address
Protection Register	00h	0Ch	Voltage MSB
Status Register	01h	C7h	Voltage LSB
			Current MSB
EEPROM Register	07h	3Ch	Current LSB
Special Feature Register	08h	FFh	Acc. Current MSB
			Acc. Current LSB
			Temperature MSB
			Temperature LSB

Read Write

Recall Copy

Pack Information Tab

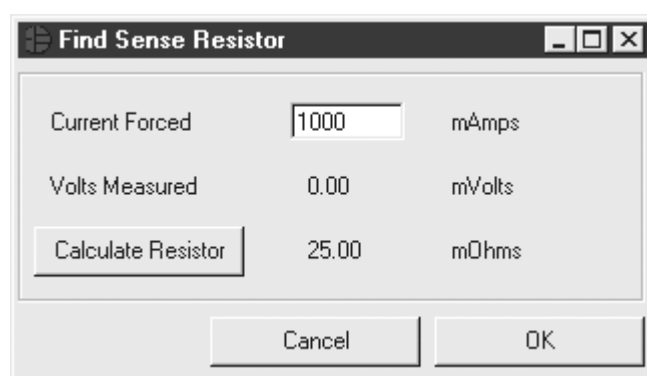
The Pack Information tab gives the pack manufacturer the ability to assign default register settings, device and sense resistor selection, and recommended manufacturer data and fuel-gauging information.

The screenshot shows the DS2762K software window with the 'Pack Info' tab selected. Within this tab, the 'Device Select' sub-tab is active. The interface includes a menu bar (File, Registers, Preferences, Help) and a series of sub-tabs (Meters, Data Log, Memory, Pack Info, Fuel Gauging). The 'Device Select' sub-tab contains a list box titled 'DS2762 Net Addresses' with three entries: 'Select Device', 'E200001079400230' (which is highlighted), and 'Anonymous Net Address'. To the right of the list box are two buttons: 'Find DS2762 Net Addresses' and 'SWAP to Selected DS2762'. Below the list box, the 'Selected DS2762 Address' is displayed as 'E200001079400230'. On the far right, there are two buttons: 'Read DS2762' and 'Write DS2762'. At the bottom of the window, there are three buttons: 'Load Default Pack Info', 'Load Saved Pack Info', and 'Save Pack Info'.

The screenshot shows the DS2762K software window with the 'Pack Info' tab selected. Within this tab, the 'Sense Resistor' sub-tab is active. The interface includes a menu bar (File, Registers, Preferences, Help) and a series of sub-tabs (Meters, Data Log, Memory, Pack Info, Fuel Gauging). The 'Sense Resistor' sub-tab contains a 'Sense Resistor Value' field set to '25.00' with the unit 'mOhms'. Below this field are two radio buttons: 'Internal Resistor' and 'External Resistor', with 'External Resistor' being selected. To the right of the radio buttons are three buttons: 'Read Sense Resistor', 'Write Sense Resistor', and 'Find Sense Resistor'. On the far right, there are two buttons: 'Read DS2762' and 'Write DS2762'. At the bottom of the window, there are three buttons: 'Load Default Pack Info', 'Load Saved Pack Info', and 'Save Pack Info'.

The Device Select sub-tab allows the user to choose which device on the 1-Wire® bus to communicate to and demonstrates the SWAP feature of the DS2762. Clicking on the Find DS2762 Net Addresses button begins a SEARCH NET ADDRESS operation on the 1-Wire bus. All DS2762s found on the bus are listed in the Net Addresses field. To communicate to any device on the bus, click on its address inside the Net Addresses field to select it. The program will now use this device for all operations until a different DS2762 is chosen. Clicking on the Swap to Selected DS2762 button demonstrates the features of the SWAP command, provided all devices on the bus have both PMOD and SWEN bits enabled in their status registers. Issuing the SWAP command causes the selected DS2762 to wake up and enable its control FETs, while simultaneously all other devices disable their control FETs and enter sleep mode. The user can shut down all devices on the bus by selecting the “Anonymous Net Address” of 0x0000000000000000h that is provided and issuing a SWAP command.

The Device Setup sub-tab shows the current state of all major features of the DS2762. All status indicators shown here directly mirror their corresponding bits in the Protection, Status, and Special Feature registers. Clicking on any of the status indicators opens the corresponding register window to allow editing. See Registers Menu above. The selection fields on the right-hand side of the sub-tab set how the EEPROM backup bits (locations 0x30h and 0x31h) will be programmed when the DS2762 is programmed with the pack information.



The image shows a dialog box titled "Find Sense Resistor". It contains three rows of data: "Current Forced" with a value of 1000 and units of mAmps; "Volts Measured" with a value of 0.00 and units of mVolts; and "Calculate Resistor" with a value of 25.00 and units of mOhms. At the bottom of the dialog are "Cancel" and "OK" buttons.

Current Forced	1000	mAmps
Volts Measured	0.00	mVolts
Calculate Resistor	25.00	mOhms

The Sense Resistor Select sub-tab allows the user to correct the current measurements if a different value of sense resistor is used. All DS2762s with an integrated sense resistor use 25mΩs. If the sense resistor is located externally, the user should select the external resistor radio button on this tab, then enter the value of the resistor in mΩs in the Sense Resistor Value field, then click the Write Sense Resistor button. The Find Sense Resistor button opens the Find Sense Resistor window. The user can then determine the resistance by forcing a known current and measuring the voltage drop with the DS2762. The resistance value is stored with one-fourth mΩ resolution into the user EEPROM of the device. The program uses this value to convert the voltage difference from the VSENS+ and VSENS- pins into milliamps. If this value does not match the value of the external resistor, current measurements will be inaccurate.

The Battery Data and Fuel Gauging Data sub-tabs demonstrate how the pack manufacturer can use the DS2762s EEPROM fields to store relevant pack information such as assembly date, chemistry, etc. The fuel-gauging characterization data is used by the fuel-gauging algorithms in the software. See the *Fuel Gauging Tab* description. Clicking on the Load Default Pack Info button enters example data into the information fields of the Device Setup, Battery Data, and Fuel Gauging Data sub-tabs. To change any of this information, simply click on the desired text field and enter the new value. Once all data is in the desired format, click on the Write DS2762 button to copy it to the EEPROM of the DS2762. This information can also be stored to a file and recalled later using the Load/Save Pack Info buttons.

Memory Map

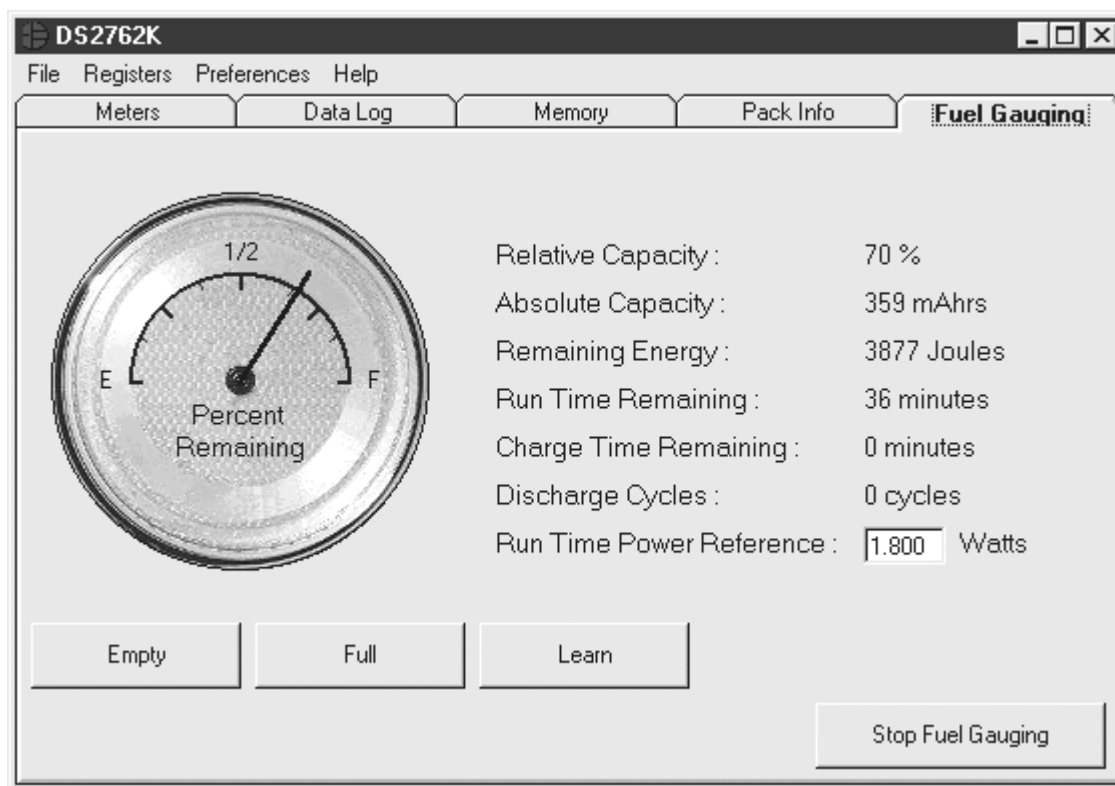
The memory map below shows the format in which the data is stored within the device. All static data is stored in Block 1, while data that might need to be updated is in Block 0. The pack manufacturer can now permanently lock Block 1 to maintain data integrity while leaving Block 0 open for access by the host processor.

MEMORY MAP OF PACK INFORMATION DATA	
0x20	Fuel Gauging—Full Point at 0°C
0x21	Fuel Gauging—Full Point difference from 10°C to 0°C
0x22	Fuel Gauging—Full Point difference from 20°C to 10°C
0x23	Fuel Gauging—Full Point difference from 30°C to 20°C
0x24	Fuel Gauging—Full Point difference from 40°C to 30°C
0x25	Fuel Gauging—Full Point difference from 40°C to 30°C
0x26	Total Accumulated Discharge—Divided by 20 to store in 2 bytes
0x27	
0x28	Fuel Gauging—Age Scalar
0x29	
0x2A	Fuel Gauging—Time from Break Point to Full at 0°C
0x2B	Fuel Gauging—Time from Break Point to Full at 20°C
0x2C	Fuel Gauging—Time from Break Point to Full at 40°C
0x2D	Fuel Gauging—Time from Empty to Full at 0°C
0x2E	Fuel Gauging—Time from Empty to Full at 20°C
0x2F	Fuel Gauging—Time from Empty to Full at 40°C
0x30	Cell Chemistry Manufacturer CE DE
0x31	PMOD RNAOP SWEN IE
0x32	Fuel Gauging—Charge Estimation Break Point in mAH
0x33	Current Offset—Do not overwrite
0x34	Sense Resistor (1/4mΩ resolution)
0x35	
0x36	Date Code—2 bytes
0x37	Fuel Gauging—Standby Empty Point difference from 0°C to 10°C
0x38	Fuel Gauging—Standby Empty Point difference from 10°C to 20°C
0x39	Fuel Gauging—Standby Empty Point difference from 20°C to 30°C
0x3A	Fuel Gauging—Standby Empty Point difference from 30°C to 40°C
0x3B	Fuel Gauging—Active Empty Point difference from 0°C to 10°C
0x3C	Fuel Gauging—Active Empty Point difference from 10°C to 20°C
0x3D	Fuel Gauging—Active Empty Point difference from 20°C to 30°C
0x3E	Fuel Gauging—Active Empty Point difference from 30°C to 40°C
0x3F	Fuel Gauging—Active Empty Point at 40°C

ADDRESSES

Fuel Gauging Tab

The final program tab performs a high-accuracy calculation of remaining cell capacity using Dallas Semiconductor's fuel-gauging algorithms. For this feature to function properly, cell characterization data must be stored in the DS2762's user EEPROM. See the *Pack Information* section. If characterization data cannot be found, the fuel gauge will not start, and an error message will be displayed. The Relative Capacity number represents what percentage of cell capacity is remaining based on present algorithm inputs such as temperature, discharge rate, etc. This value is also reflected in the analog meter. The remaining cell capacity is also displayed in terms of milliamp-hours and Joules under Absolute Capacity and Remaining Energy, respectively.



The remaining run time is calculated using the Run Time Power Reference input from the user. Instantaneous current measurements in the user's application can vary greatly. By using a reference scalar instead of actual current and voltage measurements, the program produces a stable estimation of remaining run time. The user should enter the largest expected power draw from the device into the Run Time Power Reference field for the most accurate estimation.

If this example were part of a fully integrated fuel-gauging system, the algorithms would need to be updated by the host each time the cell was fully charged or discharged in order to maintain long-term accuracy. To simulate this, the user should click the Empty or Full buttons each time the monitored pack is completely charged or discharged. The Empty button resets the Current Accumulator to the expected empty point based on present conditions. The Full button sets the Current Accumulator to the expected full point based on present conditions. The Learn button resets the expected full point to the present Current Accumulator value and updates the fuel-gauging information in the DS2762's user EEPROM. In doing this, the algorithms "learn" from previous results and are more accurate in the future. This tab gives an example only of fuel gauging. For more information on the process of high-accuracy fuel gauging, refer to Dallas Semiconductor's fuel-gauging application notes, available on our website at www.maxim-ic.com/appnoteindex.

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Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600

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